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Contents

Age-standardized Cancer Mortality Rates in Phanom Phrai District, Roi Et Province, Thailand

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Abstract

Cancer is the top leading cause of death in Roi Et, a northeastern province in Thailand. Common cancers based on prevalence were liver and intrahepatic cholangiocarcinoma (ICC), breast, colon, lung, and cervical cancers. This study was conducted to estimate age-standardized rates (ASR) of cancer mortality during 2010 in Phanom Phrai, a district in Roi Et, and compare the adjusted rates with the national ASR during 2008. The study population consisted of Thai citizens who died of cancer in Phanom Phrai during 1 Jan to 31 Dec 2010. ASR were calculated using the Segi standard population. ASR of all cancers was 69 per 100,000 population ($/10^5$). ASR of colorectal cancer in Phanom Phrai during 2010 ($10.0/10^5$) was higher than that of the national ASR in 2008 ($6.5/10^5$) and ASR of this cancer among men ($14.7/10^5$) was three times higher than that of women ($5.1/10^5$). ASR of liver and ICC ($22.6/10^5$), lung ($10.9/10^5$), cervix ($7.6/10^5$), and breast ($1.6/10^5$) in Phanom Phrai during 2010 were lower than those of the national ASR in 2008. ASR can be used to calculate cancer mortality rates for all provinces, allowing comparison and epidemiologic studies for more effective intervention.

Key words: cancer, standardization, age-standardized rate, mortality, Thailand

Introduction

During 2006-2010 in Thailand, the leading cause of death was cancer, with mortality rate of 83.1-91.2 per 100,000 population ($/10^5$).[1] In 2010, the top three cancer mortality rate were caused by liver cancer and intrahepatic cholangiocarcinoma (ICC) ($22.0/10^5$), lung cancer ($14.6/10^5$), and breast cancer ($7.7/10^5$).[2] Roi Et, a northeastern province in Thailand, had the fourth highest incidence of cancer.[3] Among males, top five cancer incidences were liver and ICC ($34.9/10^5$), lung ($10.3/10^5$), colorectal ($8.6/10^5$), leukemia ($5.2/10^5$), and lymphoma ($3.4/10^5$). In females, breast cancer was the most common cancer ($17.2/10^5$), followed by liver and ICC ($11.3/10^5$), cervical cancer ($9.8/10^5$), colorectal cancer ($8.4/10^5$), and lung cancer ($4.7/10^5$).[4]

In 2012, Chulabhorn Hospital, National Health Examination Survey Office, Roi Et Provincial Health Office and Ministry of Public Health collaborated and conducted a prospective cohort study to determine incidence and mortality of diseases, especially in cancers and cardiovascular diseases (CVD). Phanom Phrai District in Roi Et province was the study site. However, information on burden of incidence and mortalities of cancers was needed to estimate prior to carry out this project. Hence, this study was performed in order to estimate age-standardized rates (ASR) of cancer mortality in Phanom Phrai during 2010 and compare it with ASR of the national cancer mortality in 2008.

Methods

A descriptive study was conducted. Death data was retrieved from the death registry of Phanom Phrai Hospital and the National Health Security Office (NHSO). Cancer data was obtained from the cancer registry based in Roi Et Hospital and International Agency for Research on Cancer (IARC) of World Health Organization.[5] The study population was defined as people who died of cancer in Phanom Phrai District during 1 Jan to 31 Dec 2010. The inclusion criterion was people living in Phanom Phrai District and died of all causes during 1 Jan to 31 Dec 2010. People without information on age, gender, address, and date and cause of death were excluded from the study. ASR of cancer mortality in Phanom Phrai during 2010 was calculated, and compared to national and global ASR in 2008 using Segi standard population.[6]

Statistical Analysis

Data was analyzed by Epi Info version 3.5.3.[7] Mortality rate[8] was the number of death during 1 Jan to 31 Dec 2010 divided by mid-year population in

Phanom Phrai District during 2010. Age-direct standardized mortality rate of each type of cancer was calculated with Segi standard population.[6] Standard error of ASR was calculated as well.[9]

Results

Records of total 570 deaths were reviewed and 91 (16%) were excluded. Cancer was the second most common cause of death in Phanom Phrai, with ASR equal to $69/10^5$. Of these, 91 cancer deaths were identified, including 52 (57%) males and 39 (43%) females. Median ages among males and females were 64 and 68 years, and interquartile ranges were 40-77 and 58-78 years respectively. The cancer mortality rate in 2010 increased with age for both genders. Mortality rate among males aged 10-19 years and those 50-69 years were lower than those of females. In the other age groups, mortality rate among males were higher than those of females since the male population decreased (Figure 1).

We compared mortality rate by types of cancer with the national mortality rate in 2008. Top five cancer deaths in Phanom Phrai were liver and ICC, followed by colorectal, cervical, lung and hematological cancers, and contributed to 80% of all cancer deaths. As for the national mortality rate, top cancer sites were similar to Phanom Phrai, except the fifth was breast cancer (Figure 2). After ages were adjusted, top five ASR in Phanom Phrai during 2008 and the national ASR in 2010 were similar to unadjusted mortality rate (Figure 3). However, the rank of cancer mortality changed. In Phanom Phrai, although the unadjusted mortality rate of lung cancer ranked the fourth, it became the second after adjusting. Colorectal and cervical cancers were shifted to the third and fourth respectively. In addition, mortality rate also changed and after adjusting, the rate decreased for all top five cancers while the national mortality rate increased after adjustment.
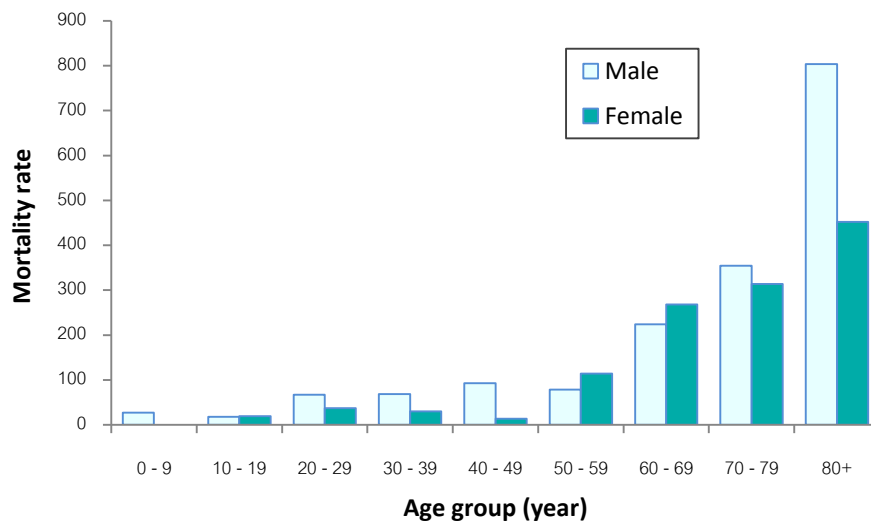

Figure 1. Mortality rates of cancer per 100,000 population by age group and gender in Phanom Phrai District, Roi Et Province, Thailand, January - December 2010 (n=91)
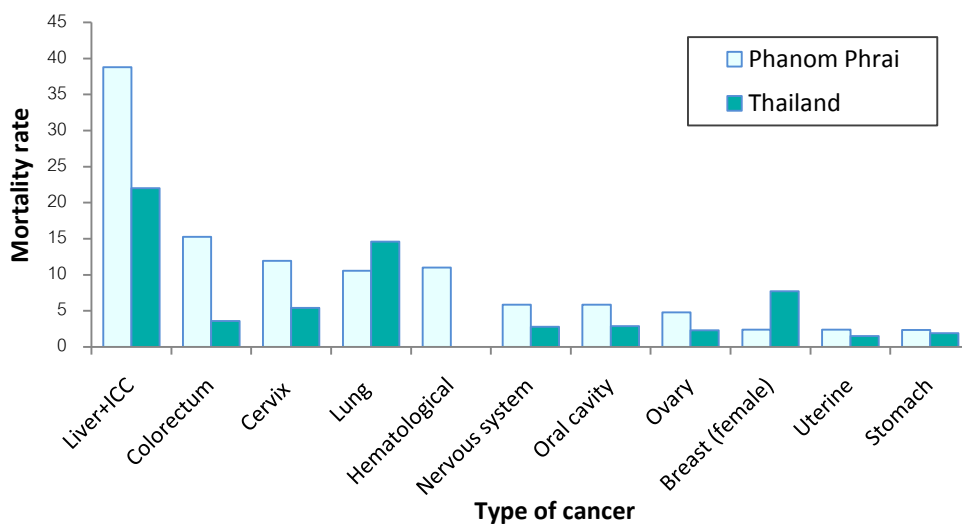

Figure 2. Mortality rates per 100,000 population by types of cancer in Phanom Phrai District, Roi Et Province, Thailand, January - December 2010
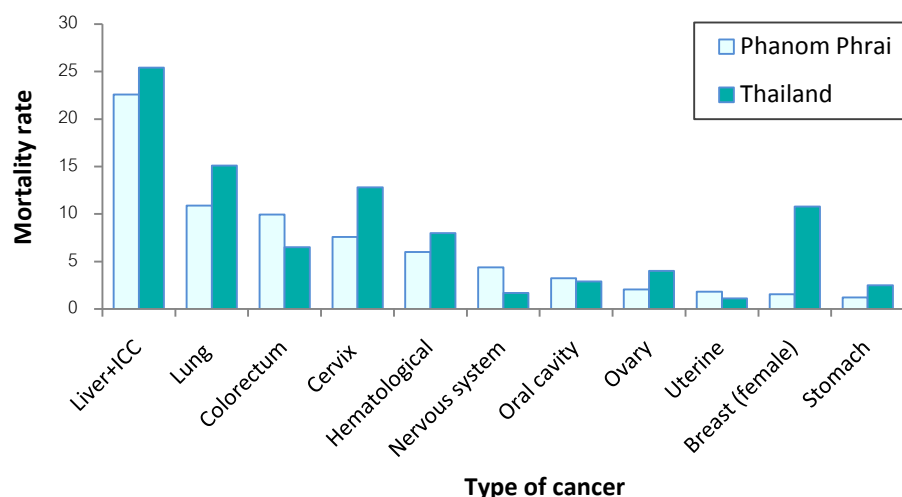
Figure 3. Age-standardized mortality rates per 100,000 population by types of cancer in Phanom Phrai District, Roi Et Province, Thailand in 2010 compared with the national rates in 2008

Five types of cancer with the highest ASR in Phanom Phrai during 2010 were selected to compare with the national and global ASR in 2008. The results showed that ASR in Phanom Phrai during 2010 were lower than those of the national and global ASR in 2008 for all types of cancer, lung, breast and cervical cancer. ASR of liver and ICC in Phanom Phrai during 2010 was lower than that of the national ASR in 2008 and higher than that of the global in 2008. For colorectal cancer, ASR in Phanom Phrai during 2010 was higher than those of both the national and global in 2008 (Table 1).

Discussion

In both genders, 80% of cancer mortality rate in Phanom Phrai was similar to those of the national, namely liver and ICC, colorectal, cervical, lung, and hematological cancers. Before age-standardization, mortality rate of Phanom Phrai in 2010 were higher than those of the national in 2008, except lung cancer. However, after adjusting, ASR of all cancers were lowered, except colorectal cancer in males which was still higher than the national ASR even after adjusting because the population structure in Phanom Phrai was different from the general Thai population. In Phanom Phrai, majority of the population were adults aged between 30-60 years with less children and elderly while majority of the general population in Thailand were children and adults[10].

Liver cancer and ICC are highly fatal diseases. Five-year survival rate was 8.5% in males and 8.3% in females,[11] due to late presentation and difficulties in surgical intervention.[12] Known risk factors included hepatitis B and C viruses, and *Opisthorchis viverrini* infection, which are prevalent in Thailand.[13-16] However, these risk factors and other underlying risk factors had never been explored in Roi Et.

Table 1. Main cancer mortalities in Phanom Phrai District, Roi Et Province, Thailand during 2010 compared with average figures in Thailand and worldwide during 2008

Type of cancer	Age-standardized mortality rate per 100,000 population		
	Phanom Phrai (95% CI)	Thailand	Worldwide
All cancers	68.9 (68.84, 68.95)	93.6	105.6
Male	83.0 (82.95, 83.12)	102.6	127.9
Female	54.4 (54.37, 54.49)	85.6	87.2
Liver cancer and ICC	22.6 (22.57, 22.63)	25.4	9.9
Male	28.7 (28.65, 28.74)	35.1	14.5
Female	16.5 (16.46, 16.53)	16.6	5.7
Lung cancer	10.9 (10.85, 10.91)	15.1	19.3
Male	13.6 (13.53, 13.63)	22.0	29.2
Female	8.1 (8.05, 8.10)	9.3	10.9
Colorectal cancer	10.0 (9.93, 9.97)	6.5	8.2
Male	14.7 (14.64, 14.69)	6.4	9.6
Female	5.1 (5.04, 5.08)	6.5	7.0
Breast cancer (female only)	1.6 (1.56, 1.56)	10.8	12.4
Cervical cancer	7.6 (7.55, 7.59)	12.8	7.8

For colorectal cancer, mortality rate in males was three times higher than that of females, which might be due to smoking and alcohol drinking among males.[17] In Thailand, frequencies of smoking and alcohol drinking in males were 18 and five times higher than those of females respectively.[18] High mortality rate in Phanom Phrai and nationwide might result from delayed diagnoses at advanced stage. As an example, among patients with known staging at diagnosis in Chiang Mai Province, almost 30% were diagnosed as advanced stages, including only 10.4% with localized disease and 29.2% with metastatic diseases.[19]

Cervical cancer is the third most common cancer affecting women around the world[20] as well as in Phanom Phrai. The high incidence might be due to high pre-cancerous lesions with 2.4% and 5.3% for conditions like infection and inflammation respectively.[21] High mortality rate in Phanom Phrai might be resulted from high rate of loss to follow-up. About 41% of patients with abnormal Pap smear were lost to follow-up according to a study in Thailand.[22]

Since structure of the population in Phanom Phrai is different from the general Thai population, it might not be appropriate to make direct comparison of the crude rates. However, age-standardization allowed comparison between two types of population by controlling the effects of different population structures. In Phanom Phrai, mortality rate decreased after adjusting because the population structure was different when compared to Segi population. Nevertheless, as the national population structure was similar to Segi population after adjusting, mortality rate increased. Although the ASR in Phanom Phrai decreased, top five cancers were still the same, which provided the strong evidence that these cancers were serious problems.

Limitations

The national and global cancer ASR, which derived from IARC, were available only until 2008. Despite that, the cancer ASR in Phanom Phrai was studied in 2010. The discrepancy in time periods might have different population structures as well. Hence, the age-standardization comparison was made for further analysis. Furthermore, as the study period for analysis was only one year, changes in trend over time could not be described or compared.

Intervention or screening programs were not reviewed or added to the analyses. Therefore, strategies on cancer prevention, early detection and treatment, could not be evaluated by this study. The data might be underestimated as well since all the people with cancer might not registered in the cancer registry based in Roi Et Hospital and National Cancer Institute, and all cancer deaths might not be diagnosed by health care personnel. Finally, as certain information such as risk and protective factors was not available at the time of recruitment, we could not explain why some cancers were lower or higher than the national and global rates in 2008.

Conclusions

We concluded that cancer-specific mortality rate in Phanom Phrai were similar to the reported national mortality rate. Cancer was the second most common cause of death in Phanom Phrai, with ASR equal to $69/10^5$. Liver and ICC, colorectal, cervical, lung, and hematological cancers caused 80% of cancer deaths in Phanom Phrai. Actions were needed to identify risk factors and effective interventions in order to reduce the disease burden.

Public Health Recommendations

We recommended that temporal changes of overall and individual cancer mortalities in Roi Et should be analyzed for longer time period such as 10 years to help in decision making for health resource allocation, and better prevention and control measures. Cancer incidence rates and trends, along with mortality rates, should be calculated for all districts, allowing comparison between districts. Finally, risk or protective factors should be explored to identify why some types of cancer were lower or higher than the national and global rates in 2008.

Acknowledgements

Suggested Citation

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A Systematic Evaluation of Dengue Vector Surveillance, Tainan City, Taiwan, 2011-2013

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Abstract

Outbreaks of dengue fever (DF) are more common in southern than northern Taiwan, with primary transmission through *Aedes aegypti* mosquito vectors. A dengue vector surveillance system (DVSS) was established in 2005, with the objectives of characterizing dengue vector distribution and evaluating the effectiveness of DF control measures. We evaluated DVSS in Tainan City, a southern city in Taiwan with DF transmission. During 2011-2013, *Ae. aegypti* predominance was found in 31% of 36 districts. Breteau, container and household indices decreased following district-level vector control campaigns in 2011 and 2013. Levels of data validity and entry error types were more than 90% and less than 10% respectively. Program completeness was found to be low at 17%, primarily influenced by rural neighborhood findings. Completeness of pupal indices was unsatisfactory (12%), limited by time and manpower in collecting pupae. This evaluation of DVSS showed that the system collected complete and valid data necessary for meeting the surveillance objectives. We recommended that completeness of DVSS be further improved in rural districts, pupal index be removed from routine dengue vector surveys, and on-the-job training of survey personnel be established and maintained.

Key words: dengue, dengue vector surveillance system, *Ae. aegypti*, Taiwan

Introduction

Dengue virus is transmitted principally by *Aedes aegypti* and the less efficient vector, *Ae. albopictus*.[1-4] In Taiwan, *Ae. aegypti* is distributed mainly in the southern part whereas *Ae. albopictus* is extensively distributed nationwide.[5] Dengue outbreaks have occurred almost annually in Taiwan since 1987 and mainly in southern Taiwan[6-7] where *Ae. aegypti* and *Ae. albopictus* coexist, especially during May to December.

In 2005, Taiwan Centers for Disease Control (TCDC) established the dengue vector surveillance system (DVSS). The surveillance is performed throughout the year in all cities and counties, with survey frequencies and resources focused on southern Taiwan. The objectives of dengue vector surveillance in Taiwan are to monitor geographic distribution of vectors and facilitate appropriate and timely decisions regarding interventions.[8] Understanding the spatial and temporal distribution of entomological information allows planners to deploy resources to high risk areas for the greatest impact on reducing disease.[9] This was the first evaluation of the DVSS in Taiwan.

Tainan City, the second largest city in southern Taiwan, is an area where *Ae. aegypti* and *Ae.* *albopictus* coexist. In 2012, Tainan City had a large dengue outbreak with 744 indigenous cases, and in 2011 and 2013, there were 95 and 38 indigenous cases identified respectively. Our aim was to ascertain that the objectives of the DVSS were being achieved.

Methods

Identification of Target Area

Tainan City has 37 districts divided into 752 neighborhoods. We defined six districts (East, West Central, South, North, Anping and Annan Districts) in Tainan metropolitan area as urban (41% of population) and the remaining districts as rural.

Study Design

Our study design was a descriptive approach and ecological analysis. We described the operation of DVSS and evaluated DVSS following the guidelines from United States Centers for Disease Control and Prevention (CDC)[10]. Resources of personnel time and cost were also calculated. Selected attributes for the evaluation were usefulness, data quality, simplicity, representativeness and timeliness. Sensitivity, specificity and positive predictive value were not assessed as no good alternative data was available for comparison.

Data Collection and Indicator Definitions

We extracted the DVSS data on all variables submitted from 2011 to 2013, including number of inspected houses, positive inspected houses, water-holding containers, positive water-holding containers, and larvae, pupae and adult *Aedes* mosquitoes (*Aedes aegypti* and *Aedes albopictus*). A positive house or water-holding container was defined as any house or water-holding container found to have *Aedes* larvae or pupae.

Vector surveillance indicators included the Breteau index (BI, number of positive containers per 100 houses inspected), house index (HI, percent of positive houses), container index (CI, percent of positive water-holding containers), pupal index (PI, number of pupae per 100 houses inspected) and adult index (AI, number of female adult mosquitoes per house inspected)[8,11]. In addition, percent of *Ae. aegypti* was defined as the cumulative number of *Ae. aegypti* larvae among *Ae. albopictus* and *Ae. aegypti* larvae during a designated time period. Finally, "*Ae. aegypti* predominant districts" were defined if percent of *Ae. aegypti* larvae at the district level is 50% or more. Vector surveillance data was displayed on maps using geographic information systems software Quantum GIS (version 1.7.4).

Evaluation of Attributes

Usefulness was evaluated by looking at the findings of spatio-temporal analysis of DVSS data which identified the distribution and density of areas at risk for dengue transmission. Ecological analysis was performed by linking DVSS data to control measures and the burden of dengue cases. This was performed for one district identified with dengue disease burden higher than other districts.

Data quality was evaluated by assessing data completeness and validity. Data completeness was defined as percent of records with complete data (no missing) which represented surveys conducted in neighborhoods (over 50 households). Validity was defined as percent of records with logically recorded data for each variable. We reviewed all variables and identified seven illogical data scenarios and combinations of values for these variables. Next, we calculated percent of these illogical (error) data entries. We defined 90% or above as a satisfactory level of completeness/validity and reported results as "satisfactory" or "unsatisfactory" if results were 90% and more, or less than 90% respectively[12].

Simplicity was evaluated through face-to-face or telephone interviews of key surveillance staff using a semi-structured questionnaire. The questionnaire asked about understanding on the objectives of DVSS, and whether the interviewee found the system useful, easy and quick to use. Interviewees were selected based on their availability and willingness to participate as well as their expertise in vector survey and/or technology experience.

Representativeness was evaluated by geographic and temporal findings, which was also associated with program completeness. We defined program completeness as percent of neighborhoods in each district which achieved the survey standard, which was that all neighborhoods were to be surveyed at least once every two months[13].

Timeliness was evaluated by measuring the duration between date of survey by field investigators and date of data entry into the web-based system, which should be within seven days, according to the dengue control guideline of Tainan City[13].

Ethical Considerations

Since this study did not involve human subject research, it was exempted from an Institutional Review Board review.

Results

Surveillance Operation

Figure 1 shows the operational flow of DVSS, including local, regional and national activities. Data generated for DVSS comes from the vector surveys program conducted by field investigators in neighborhoods, each of which should be surveyed at least once every two months. The survey should be conducted 50 or more houses and apartments in the neighborhood and inspected for containers with mosquito larvae or pupae. In addition, when a dengue case was reported or confirmed, field investigators should conduct vector inspection of 50-100 households around where dengue cases had occurred, in accordance with the dengue control guideline[7]. In each neighborhood, the data were entered into the web-based system within seven days of survey. If BI value was more than nine, community mobilization and messaging efforts were triggered to eliminate mosquito breeding sites. TCDC support all of these activities, performed data analysis and disseminated weekly reports to stakeholders (local heath bureaux, and regional centers and Epidemic Intelligence Center of TCDC) for policy or programmatic decision making.

Resources

Total number of staff operating the system was 76, including local, regional and national staff (Table 1).

7

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                                    Field investigators (Local)          daily
                        ┌──────────────────────────────────────┐
     weekly             │      Mosquito density survey           │
     follow up          │              │ weekly                  │     High BI
                        │      Data collection & submission       │     weekly
          BI>9          │              │                          │     follow up
          weekly        │      Web-based dengue vector            │
          follow up     │      surveillance system                │
                        │              │                          │
   BI>9   Local health  │  CDC/ Center for Research, Diagnostics   │  CDC/regional
          bureau        │  and Vaccine Development (National)      │  center
          (Regional) &  │              │ weekly                   │
          station       │  Data analysis in web-based system      │
          (Local)       │              │ weekly                   │
                        │      Report dissemination               │
   • Notify local       │              │                          │
     environmental      │  Local health bureau and CDC/regional center, │
     department &       │  Epidemic Intelligence Center            │
     district office    └──────────────────────────────────────┘
   • Community
     mobilization
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* Survey frequency is adjusted during the outbreak.

Figure 1. Flow chart of operation within dengue vector surveillance system in Tainan City, Taiwan, 2011-2013

Table 1. Resources of dengue vector surveillance system, Tainan City, Taiwan, 2011-2013

Personnel time cost	Government/ Organization	Unit	Hour per month	Hour per year
Staff (n=1)	TCDC	Epidemic Intelligence Center	8	104
Information technologist (n=1)	TCDC	Information Management Office	20	260
Analyzer (n=1)	TCDC	Center for Research, Diagnostics and Vaccine Development	24	312
Staff (n=2)	TCDC	Southern Regional Center	64	832
Staff (n=3)	Tainan City	Local health bureau	96	1,248
Staff (n=37)	Tainan City	Local health station	1,184	15,392
Field investigators (n=31)	Tainan City	Local health bureau	4,960	64,480
Total (n=76)			6,356	82,628

Cost	Government/ Organization		Annual Cost (USD)	Cost (USD)
System construction	TCDC			0.02 million
System new function expansion	TCDC		4-8,000	
System maintenance	TCDC		4,000	
Field investigators	Tainan City		0.19 million	
Total			0.2 million	

The only full-time staff were TCDC-funded field investigators. The annual maintenance costs covering the field investigators and hardware, including a back-up computer system, was approximately USD 0.2 million.

Usefulness

During 2011-2013, dengue vector surveillance data from 37 districts in Tainan were submitted into DVSS, and 36 of these had data on *Aedes* species. One district had no *Aedes* species data because this district was surveyed less and had neglected to classify *Aedes* species. Total 11 (31%) of the 36 districts were *Ae. aegypti* predominant (i.e. percent of *Ae. aegypti* larvae 50%), including five urban districts (Figure 2). In some districts, percent of *Ae. aegypti*

larvae was 50% for all three years (Figure 3).

During 2011-2013, the West Central District in Tainan had yearly dengue outbreaks with district-level campaigns for breeding site elimination. Therefore, we used West Central District as an example to evaluate control measures. Increased BI, CI and HI showed seasonality and appeared to precede outbreaks of disease (Figure 4). In general, campaigns appeared to result in decreasing levels of BI, CI, HI and dengue cases. Although, in 2012, number of dengue cases and the three indices decreased initially after the campaign, it rebounded, triggering elevation of the command level and coordination efforts in week 40 of 2012. It was only after these enhanced measures, BI, CI, HI and case levels went down.
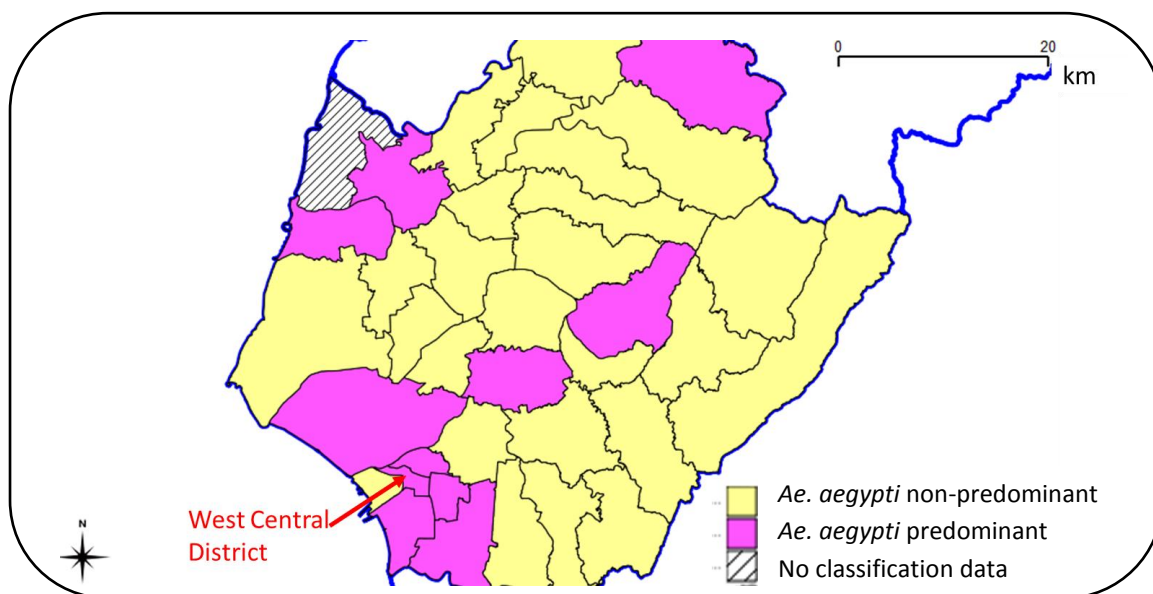

Figure 2. *Ae. aegypti* predominant and non-predominant areas in Tainan City, Taiwan, 2011-2013
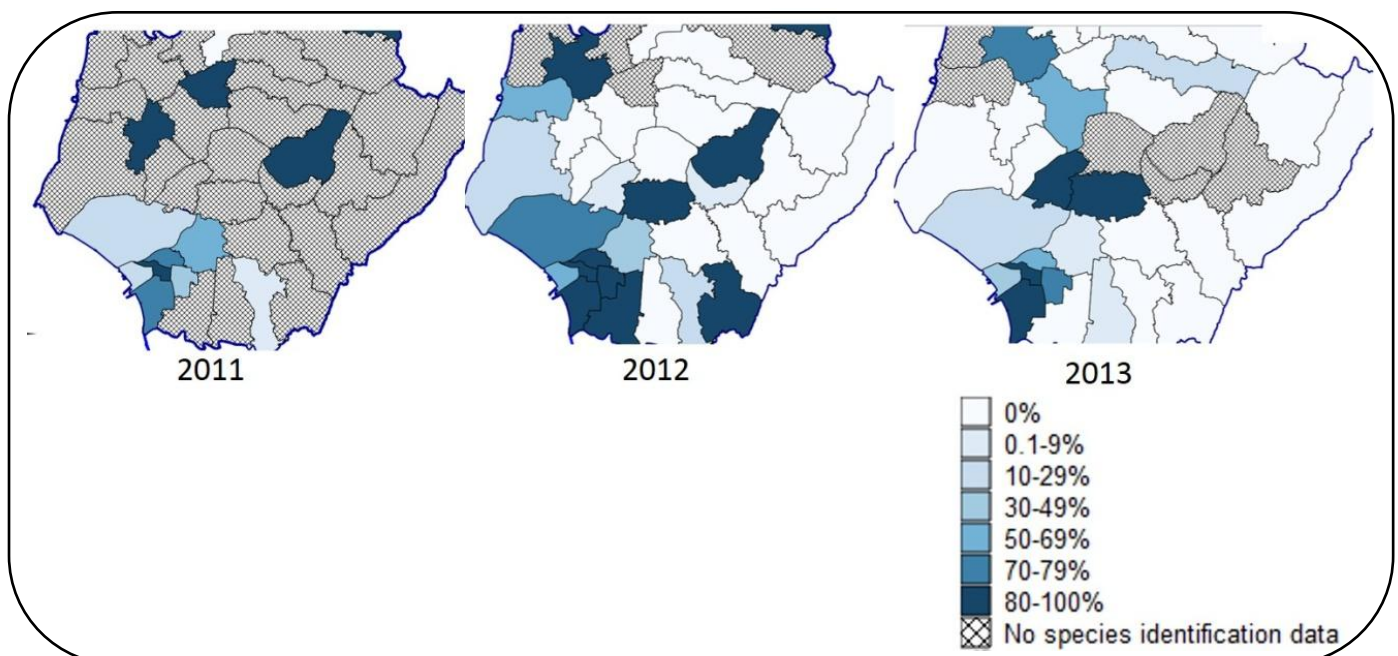

Figure 3. Yearly percentage of *Ae. aegypti* in Tainan City, Taiwan, 2011-2013

Data Quality

During the 3-year period, 25,877 neighborhood-vector surveys were recorded to DVSS in Tainan. Data quality was evaluated by data completeness and validity of measured indices (BI, CI, HI, PI and AI). Completeness of the indices in 2011-2013 varied from 11.81% to 99.95% (Table 2). The variable "PI" displayed an unsatisfactory level of completeness, with only 12% of records completed. For validity, variables of logical entry error ranged from 0.01% to 4.56% (Table 3).

Table 2. Completeness of indices survey in Tainan City, Taiwan, 2011-2013 (n= 25,877)

Indices	Completeness (%)			
	2011	2012	2013	2011-2013
Breteau index	99.89	100	100	99.95
House index	99.89	100	100	99.95
Container index	97.70	99.02	98.91	98.41
Pupal index	10.55	10.96	15.38	11.81
Adult index (*Ae. aegypti*)	99.89	100	100	99.95
Adult index (*Ae. albopictus*)	99.89	100	100	99.95

All respondents agreed that DVSS was clear, easy to use, useful, quick, and the skills required to use the system existed in their teams. Moreover, the indices were automatically calculated after data entry with debugging mechanisms like warning messages during data entry. *Ae. aegypti* and *Ae. albopictus* could be simply identified by microscopy. However, questions about the ease of identifying *Aedes* pupae were not included in the interviews.

Representativeness

During the 3-year period, 727 (97%) neighborhoods were surveyed at least once. Of which, 231 (32%) were in the urban and 496 (68%) in the rural. In accordance to the program requirement, i.e. all 752 neighborhoods in Tainan to be surveyed at least once every two months, we found that only 17% of the neighborhoods complied with this standard. Compliance in urban versus rural district surveys was 46% (107 among 231 neighborhoods in urban districts) versus 4% (21 among 521 neighborhoods in rural districts) respectively. In addition, 75% of the survey was conducted during May to December, the time period considered to be the outbreak season.

Timeliness

Median length of time from survey data collection to data entry was three days (range 0-790 days), with adherence to the 7-day standard at 84%. If we analyzed medians of timeliness by type of districts, it
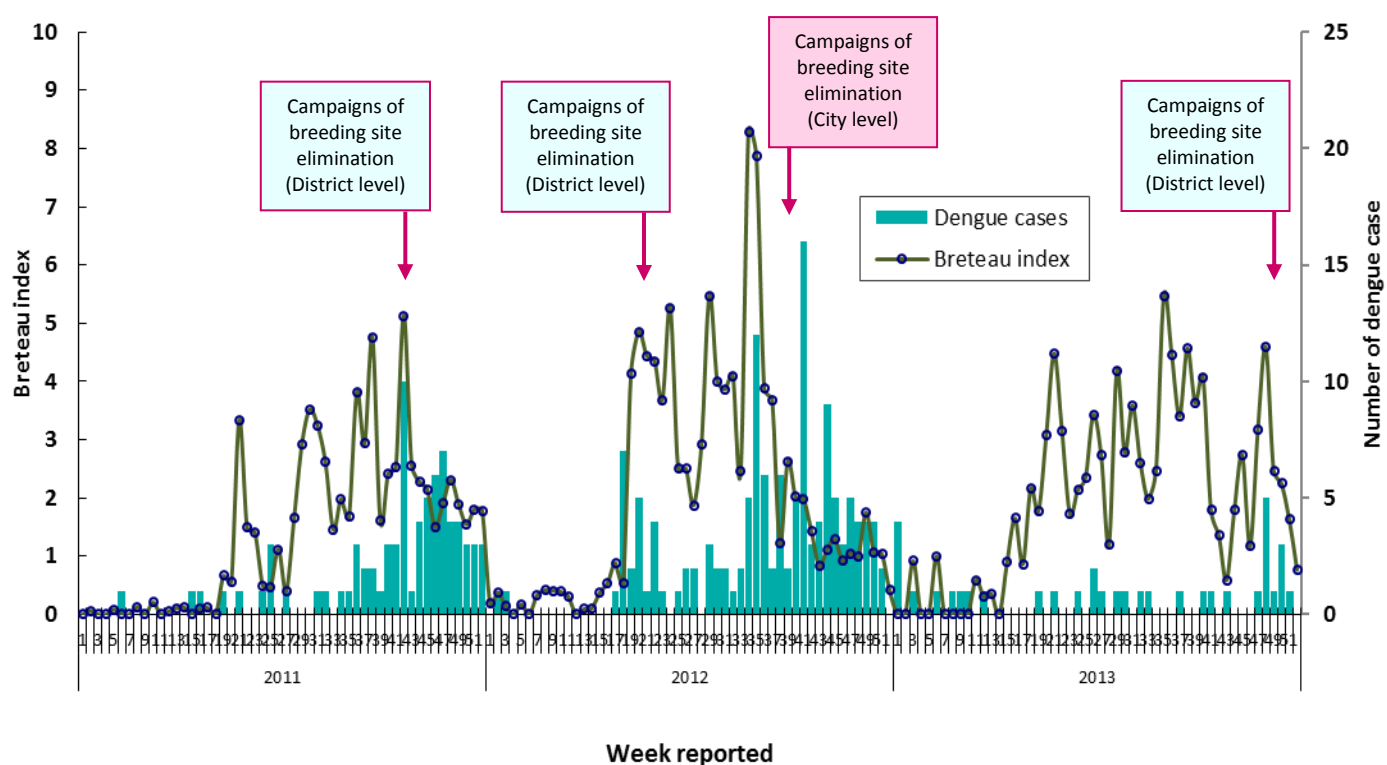

Figure 4. Number of dengue cases reported and Breteau index in West Central District of Tainan City, Taiwan, 2011-2013

Table 3. Entry errors of variables of Dengue Vector Surveillance System in Tainan City, Taiwan, 2011-2013 (n= 25,877)

Entry error type	Entry error percent (%)			
	2011	2012	2013	2011-2013
Number of household = 0	0.11	0	0	0.05
Number of (+) household > 0, but number of water-filled container = 0	0.06	0	0.02	0.03
Number of (+) household > 0, but number of (+) container = 0	0.15	0	0	0.07
Number of (+) household > number of household	0	0.01	0.02	0.01
Number of (+) container > 0, but number of (+) household = 0	0.58	0	0	0.26
Number of (+) container > 0, but number of larvae and pupa = 0	2.69	7.26	3.54	4.56
Number of (+) container > number of water-filled container	0	0	0.03	0.01

was shorter in urban districts (median 2 days, range 0-790 days, IQR 1-4 days) versus rural districts (median 4 days, range 0-517 days, IQR 1-10 days). However, the difference was not statistically significant (p-value>0.05). Although the standard interval between data analysis and use of the data (e.g. notification for control campaigns) was recommended to be weekly (seven days), we did not evaluate it in this study.

Discussion

Our evaluation of DVSS in Tainan City showed the system achieved its stated objectives. The simplicity of DVSS was found to be a key attribute leading to timely and accurate data entry. DVSS was also characterized by high level of data completeness and the validity of key variables was believed to represent features of a high quality dengue fever surveillance system in Taiwan.

Although entomological surveillance is used for operational purposes and evaluation of control measures, the relationship between vector indices and disease transmission in dengue virus is not well conclusive[14]. Our study findings supported the use of BI, CI, and HI as a measurement for disease control campaign impact. Although BI was considered to be the better index as it is more qualitative and has more epidemiological significance in previous studies[15-16], BI seems to perform similarly as CI and HI in our study. In 2012, the number of dengue cases and BI decreased initially after the campaign, however, it rebounded again. This might be due to the fact that new breeding sites were created or the campaign was not implemented thoroughly. However, as the three indices and the dengue incidence decrease after control campaigns, further studies were needed to confirm this.

The only variable with low data completeness was the PI. The reasons for the low PI completeness were speculative. Investigators might not record field results or entered results into the system. In addition, the investigators might think that it might not be necessary to record PI because it was not a routine index presented in the weekly report. Furthermore, it was time-consuming and laborious as samples must be transported back to the laboratory for microscopy to differentiate *Aedes* pupae from other mosquito species.

Since some studies showed that the survival rate of pupae was higher than larvae, PI could predict the risk of dengue outbreaks better than BI.[17-18] However, PI is not commonly used to monitor vector density because of limited time and manpower, especially when large containers are present as more time and manpower are needed to sort through the various larvae and pupae[19]. Furthermore, pupal surveys may be incomplete and therefore, results are not representative and limit their usefulness in predictability.[20-21] As PI seems to be less feasible and required more time and manpower to collect individual pupae from large containers and identify the co-existing *Aedes* species properly in the same container[22], we did not recommend to use for routine dengue vector surveys.

Although there was high data completeness of key variables, program completeness was low in rural districts, with most indigenous cases in urban districts (e.g. 93% in urban districts in Tainan). Even though the program required all neighborhoods be surveyed at least once every two months, it lacked an auditing mechanism. Therefore, the survey personnel often focused on urban districts, which were known to have high dengue disease burden, in response to public concerns of potential dengue outbreaks and

ignored rural districts. Furthermore, during dengue outbreaks, most investigators and resources were focused on outbreak areas rather than low incidence areas. Therefore, the discrepancy in geographic program completeness might be influenced by diversion of staff during outbreaks.

This study had the following limitations. First, 50 and more inspected houses/apartments were non-randomly selected in each neighborhood to find containers positive for mosquito larvae or pupae and capture adult mosquitoes to calculate mosquito indices such as BI, HI, CI, PI and AI. As a result, inspected houses/apartments were subjected to selection bias. Furthermore, the numbers of adult mosquito found might be influenced by the skill of the investigators. In addition, interviews with stakeholders might have had reporting bias. Finally, identification of adult and larvae species might be misclassified by the investigators. Previous studies showed that education or training was successful in stimulating changes in both knowledge and behavior to identify *Aedes* larvae and reduce *Aedes aegypti* habitats.[23-24] Continuous education and on-the-job training could be instituted to reduce misclassification.

Public Health Recommendations

To effectively support a public health response, comprehensive dengue vector surveillance was necessary to establish a clear understanding of the density and distribution of dengue vectors in each region of Taiwan. The completeness of DVSS could be further improved in rural districts to elevate geographic representativeness. Furthermore, PI seemed less feasible and useful, and thus, we did not recommend its use in routine dengue vector surveys. Finally, the mechanism for continuous education and on-the-job training of survey personnel should be established and maintained.

Acknowledgements

Suggested Citation

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Assessment on Exposure to Highly Pathogenic Avian Influenza A(H5N1) and Poultry Trading Practices among Poultry Traders in Traditional Markets of Sukoharjo District, Central Java Province, Indonesia, 2012

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Abstract

Sukoharjo District has been an endemic area of highly pathogenic avian influenza (HPAI) subtype A(H5N1). We conducted a serology investigation to determine the level of human exposure to HPAI A(H5N1) and describe trading practices of poultry in eight live bird markets in Sukoharjo. A cross-sectional study was conducted in traditional markets. Total 75 traders were selected using simple random sampling proportionally from 221 traders in all eight markets. Serum samples were tested for H5N1 antibody titer by hemagglutination inhibition test. There was no trader with positive H5N1 antibody. Majority of the traders washed carcasses (84.0%), used containers to carry poultry and carcasses (94.7%), and cleaned places of trading (94.7%). Poultry traders had not been infected by HPAI A(H5N1).

Key words: HPAI A(H5N1), antibody titer, poultry traders

Introduction

Highly pathogenic avian influenza (HPAI) subtype A(H5N1), also known as bird flu, is a zoonotic disease of poultry and caused by type A influenza viruses of the family *Orthomyxoviridae*. HPAI A(H5N1) viruses can also infect humans, causing severe respiratory symptoms or deaths.[1,2]

The current epidemic of HPAI A(H5N1) began during late 2003 in southern China, and quickly spread to Vietnam, Thailand, Indonesia and East Asian countries.[3] Since it was first detected in late 2003, HPAI A(H5N1) viruses have infected people from 31 out of total 34 provinces in Indonesia, and millions of birds died from the virus. Despite the widespread, the incidence of HPAI A(H5N1) outbreaks among poultry gradually decreased every year from 2006 to 2011.[4] Human infection with HPAI A(H5N1) was first reported in Indonesia during 2005. By March 2012, there were 155 confirmed human cases, marking Indonesia with the highest number of human casualties due to avian influenza globally.[5] The first outbreak in Sukoharjo was reported during 2008, with number of poultry deaths reported as many as 2,006 from 12 sub-districts in May 2012[6] while human cases were reported in 2007 and 2009. As of May 2012, two confirmed cases of human infection were identified with HPAI subtype H5N1.[7]

Traditional market supply of live poultry and carcasses is one of the important factors for spread of HPAI virus subtype H5N1.[2,8] Live bird markets (LBM) are also sources of infection for humans, especially for poultry traders who handle poultry themselves.[8,9] People can be infected with HPAI A(H5N1) through contact with infected poultry either via direct contact or processing for consumption.[8]

This study was proposed to determine the level of human exposure to HPAI A(H5N1) and describe poultry trading practices at LBM in Sukoharjo.

Methods

A cross-sectional study was conducted among 221 poultry traders who were in all eight traditional markets in Sukoharjo between April and May 2012. Total 75 traders were recruited to estimate 50% prevalence at 95% confidence, with precision of 10% and estimated drop out of 10%[10]. Number of samples in each market was allocated proportionally to number of traders in the market. Within each market,

traders were selected randomly[11] and collected their serum samples which were submitted to Basic Biomedicine and Technology of Health in Jakarta for laboratory testing using hemagglutination inhibition (HI) assay to determine antibody titer against HPAI A(H5N1) viruses. Serum samples with HI titer 40 or more were identified as positive, indicating previous exposure and infecting with the viruses.[12,13]

Questionnaires were developed to gather information from the participating traders on their characteristics such as gender, age, level of education and contact details. The questionnaires also inquired information on sources of birds, trading practices, transportation, slaughtering practices and previous contact with sick or dead poultry prior to the study. The researchers interviewed the participating traders using the questionnaire during sample collection.

Prevalence of seropositivity and associated 95% confidence interval were calculated to determine level of exposures among the participating traders. Descriptive analysis of attributes collected from the questionnaires was performed. The study also examined the possible associations between traders' characteristics and their trading and slaughtering practices which might increase the risk of HPAI exposure. The associations were then characterized by odds ratios (OR) with 95% confidence intervals.

Results

Total 75 traders were included in the study. Majority of them were females (74.7%) and age 41-60 years old (64.0%) following by 20-40 (30.7%) and more than 61 years old (5.3%). Their highest education backgrounds were elementary school (40%), junior high school (29.3%), senior high school (28%) and bachelor degree (2.7). Most of them had 6-15 years experience (62.7%) of being poultry trader and they did poultry trading without any other side jobs (69.3%). They traded poultry products such as carcass and meat (77.3%), live poultry (20.0%) and both (2.7%). Majority of them traded broiler chickens (77.3%), followed by domestic poultry (18.7%), birds (2.7%) and ducks (1.3%). The traders also kept some live poultry for selling. It included domestic poultry (18.7%), birds (2.7%), ducks (2.7%), broilers (1.3%) and multiple species (8.0%) (Table 1).

Sukoharjo District has 12 sub-districts defined as endemic areas of HPAI, except Bendosari, Weru, Bulu, Gatak and Grogol. From our study population, poultry were originated from Sukoharjo, Kartasura, Polokarto, Gatak, Nguter, Tawangsari, Mojolaban, Bendosari, Weru, Bulu, Grogol, Baki and other

Table 1. Demographic characteristics of poultry traders from markets in Sukoharjo District, Central Java Province, Indonesia, 2012 (n=75)

| Characteristic	Number	Percent
Gender		
Male	19	25.3
Female	56	74.7
Age group (year)		
20-40	23	30.7
41-60	48	64.0
≥ 61	4	5.3
Education		
None	0	0
Elementary	30	40.0
Junior high school	22	29.3
Senior high school	21	28.0
Diploma	0	0
Bachelor/university	2	2.7
Side Job		
Farmer	11	14.7
Livestock trader (large animals)	2	2.7
Fish trader	2	2.7
Labor	1	1.3
Rickshaw puller	2	2.7
Grocery trader	2	2.7
Plastic trader	1	1.3
Multi-level Marketing seller	1	1.3
Traditional soy product (Tempe) maker	1	1.3
None	52	69.3
Working period (year)		
< 5	13	17.3
6-10	25	33.3
11-15	22	29.3
16-20	6	8.0
21-25	3	4.0
> 26	6	8.0
Bird species being traded		
Broilers	58	77.3
Domestic poultry (Buras)	14	18.7
Ducks	1	1.3
Birds	2	2.7
Kind of birds being kept		
Domestic poultry (Buras)	14	18.7
Broilers	1	1.3
Ducks	2	2.7
Domestic poultry (Buras) and ducks	3	4.0
Range chickens, broilers and ducks	1	1.3
Birds	2	2.7
Birds and other poultry	2	2.7
Type/form poultry trade		
Live poultry	15	20.0
Carcass/meat of poultry	58	77.3
Live poultry and carcass/meat of poultry	2	2.7
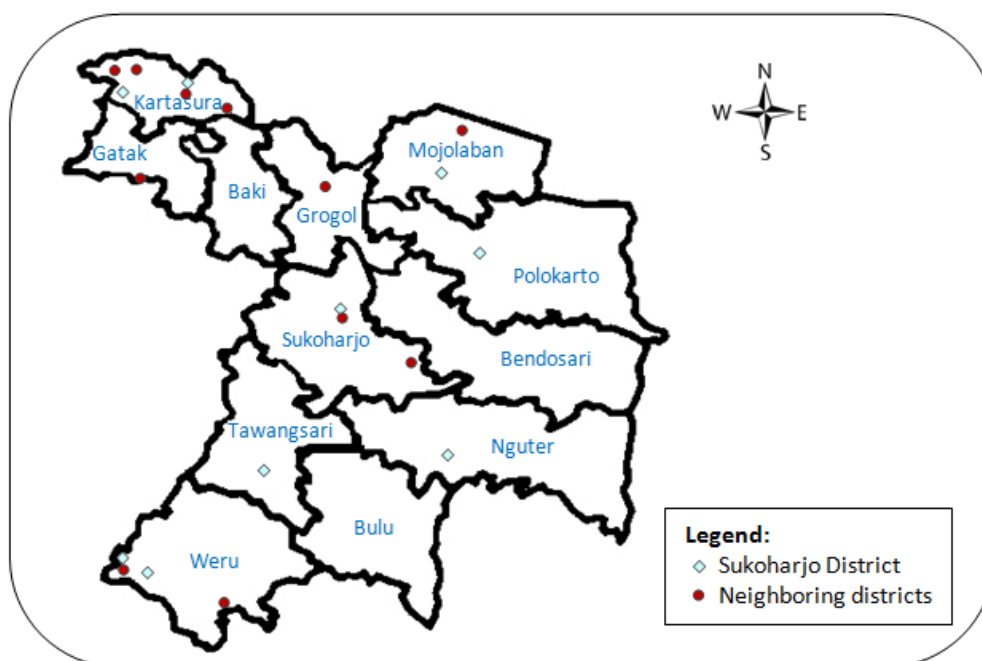
Figure 1. Distribution of Poultry Origins in Sukoharjo District, Central Java Province, Indonesia, 2012

neighboring districts. Thus, poultry sold in the eight traditional markets came from Sukoharjo and neighboring districts which were endemic areas as well (Figure 1).

History of possible exposure to HPAI of the traders was categorized into direct and indirect contact. Majority of direct contact exposure among traders was through butchering poultry (80.0%) and washing carcasses (84.0%) while few of them had only contacted with dead poultry (28.0%). Indirect contact among traders was through transporting poultry or carcasses (94.7%) and cleaning trade location (94.7%). Not all of them washed their hands after the trading (Table 2). Even though, the traders had high risk of exposure, all 75 traders had negative titer of H5N1 antibody.

When we examined the two most frequent exposure or risk behaviors of the traders, slaughtering poultry and washing carcass/offal, we found that traders aged 40 years and above had a tendency to slaughter poultry 32.5 times more than those of 20-40 years old. Less educated traders had more tendency than highly educated traders in washing the carcass/offal of poultry (Table 3).

Table 2. Risk factors related to poultry among poultry traders from markets in Sukoharjo District, Central Java Province, Indonesia, 2012 (n=75)

Risk factor	Number	Percent
Direct contact		
Slaughtering	60	80.0
Plucking feathers	58	77.3
Washing carcass/offal	63	84.0
Contact with carcass	21	28.0
Maintaining	25	33.3
Indirect contact		
Transporting poultry/ carcass with container	71	94.7
Washing hand after trade	65	86.7
Cleaning place of trading	71	94.7

Discussion

All 75 samples had negative H5N1 antibody titer which might be due to the fact that poultry traders or workers (both males and females), though highly exposed to live poultry, have limited exposure to H5N1 virus in the markets.[14] The finding was similar to a study in Sukabumi (West Java)[15] as well as one study in eight provinces (Lampung, Banten, West Java, Central Java, Yogyakarta, East Java, Bali and Kalimantan).[14]

Table 3. Relationship between risk factors and demographic characteristics of poultry traders from markets in Sukoharjo District, Central Java Province, Indonesia, 2012

Risk factor	Characteriristic	Odds ratio	95% CI
Slaughtering poultry	Age ($\geq$ 40 years)	32.5	6.33-166.91
Washing carcass/offal	Educated (less-medium)	62.0	2.06-1864.98

Majority of the traders slaughtered poultry, plucked feathers, washed carcasses, handling dead poultry and cleaning places of trading. However, they were all negative for H5N1 antibody. This finding implied that the traders had not been infected by H5N1 virus prior to blood collection although they had high risk behaviors.[16-18]

The results showed the H5N1 antibody titer negative in traders who raised poultry and did not keep poultry regardless of vulnerable species as well as the traders who sold live poultry. This was probably because the traders maintained and sold live poultry that were not infected with H5N1 virus. Based on the opinions of previous researchers, maintaining poultry of random species and selling live poultry could infect people with H5N1 virus. Sensitive bird species such as chickens, turkeys, quails, ornamental chicken, and various kinds of domestic and wild birds can be infected with H5N1 virus. Ducks, geese, gulls and shorebirds can be carriers for all types of influenza A virus subtypes that have the potential to mutate into highly pathogenic as H5N1 after moving and adapting to the new hosts.[19,20]

Negative H5N1 antibody titer could also be due to low titer from cross-neutralization by circulating antibody after previous infection by human influenza virus,[21,22] which could occur in mild flu or asymptomatic H5N1 infection.[23] In addition, the last endemic incidence of H5N1 among fowls in Sukoharjo was in February 2011, and thus, the antibody level might be no longer detectable.[24] Furthermore, as this research used H5N1 antigen in 2012 which was not derived from similar areas and year,[15] there might be changes in amino acid of 2012 H5N1 antigen. Low antibody response induced by H5N1 virus with mutation could not be detected by HI test.[15] Negative or low titer might be caused by genetic and specific receptor factors as well.[25]

It was found that age and education of the traders were significantly associated with behaviors which increased the risk of HPAI exposure. The findings were similar to other studies which were conducted among poultry farmers, sellers, chicken product handlers and workers in poultry collection facilities.[8,14,16]

Conclusion

Based on our study, poultry traders in Sukoharjo District had not been infected by HPAI A(H5N1) since all poultry traders in the traditional markets in Sukoharjo District had negative antibody titer of H5N1. However, almost all traders were highly exposed to live poultry and carcasses which could increase their risk of getting HPAI infection once the agents spill into the market.

Recommendations

Assessment on exposure to HPAI A(H5N1) should be continued among poultry traders in the traditional markets. The Department of Health should identify effective methods including sero-surveillance to detect the infection early with proper timing of specimen collection and better screening test of H5N1 antibody.

Suggested Citation

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